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A Ten-Year Self-Review of Safety Assessment Framework for Dry Systems under Impact Loadings: Methods and Research Prospects

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Handling, transporting, and storing spent nuclear fuel (SNF) present enduring challenges from more than 70 years of nuclear power operations. Transportation and storage systems are rigorously evaluated for criticality, shielding, heat, and structural integrity under conservative conditions, optimized through system analysis. The load conditions for assessing the structural safety of SNF casks are categorized as normal, off-normal, accident, and natural phenomena. Extensive tests of SNF containers to simulate 99% of all travel-related accidents were conducted, while test data acquisition was mainly used to develop and validate sophisticated computer models. The tests also considered further severe impacts, confirming the package's ability to contain the SNF and the accuracy of the computer analyses. The most severe design-based accidents involving transportation casks typically include a 9-meter drop onto a rigid surface, considering various impact orientations. In the context of storage facilities, an aircraft impact is regarded as one of the most significant risks during the SNF storage phase, despite the low probability of occurrence. These two severe cases encompass a wide range of impact loads. Efforts have been made to develop methods for modeling and simulating these two cases within a safety assessment framework. This involves addressing varied impact conditions and considering the characteristics of SNF and their detailed responses [1-10].

This research provides an overview of the primary methods proposed, assumptions related to numerical and modeling, and impact conditions developed by the author. Finally, it highlights knowledge gaps and areas that require further investigation.

Technical Track

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